



Designation: E1210 – 16

# Standard Practice for Fluorescent Liquid Penetrant Testing Using the Hydrophilic Post-Emulsification Process<sup>1</sup>

This standard is issued under the fixed designation E1210; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice covers procedures for fluorescent penetrant examination utilizing the hydrophilic post-emulsification process. It is a nondestructive testing method for detecting discontinuities that are open to the surface such as cracks, seams, laps, cold shuts, laminations, isolated porosity, through leaks, or lack of fusion and is applicable to in-process, final, and maintenance examination. It can be effectively used in the examination of nonporous, metallic materials, both ferrous and nonferrous, and of nonmetallic materials such as glazed or fully densified ceramics and certain nonporous plastics and glass.

1.2 This practice also provides a reference:

1.2.1 By which a fluorescent penetrant examination hydrophilic post-emulsification process recommended or required by individual organizations can be reviewed to ascertain their applicability and completeness.

1.2.2 For use in the preparation of process specifications dealing with the fluorescent penetrant examination of materials and parts using the hydrophilic post-emulsification process. Agreement by the purchaser and the manufacturer regarding specific techniques is strongly recommended.

1.2.3 For use in the organization of the facilities and personnel concerned with the liquid penetrant examination.

1.3 This practice does not indicate or suggest standards for evaluation of the indications obtained. It should be pointed out, however, that indications must be interpreted or classified and then evaluated. For this purpose there must be a separate code or specification or a specific agreement to define the type, size, location, and direction of indications considered acceptable, and those considered unacceptable.

1.4 The values stated in inch-pound units are regarded as standard. SI units given in parentheses are for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the*

*responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.6 All areas of this practice may be open to agreement between the cognizant engineering organization and the supplier, or specific direction from the cognizant engineering organization.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

D129 Test Method for Sulfur in Petroleum Products (General High Pressure Decomposition Device Method)

D516 Test Method for Sulfate Ion in Water

D808 Test Method for Chlorine in New and Used Petroleum Products (High Pressure Decomposition Device Method)

D1552 Test Method for Sulfur in Petroleum Products by High Temperature Combustion and IR Detection

E165/E165M Practice for Liquid Penetrant Examination for General Industry

E433 Reference Photographs for Liquid Penetrant Inspection

E543 Specification for Agencies Performing Nondestructive Testing

E1316 Terminology for Nondestructive Examinations

E2297 Guide for Use of UV-A and Visible Light Sources and Meters used in the Liquid Penetrant and Magnetic Particle Methods

E3022 Practice for Measurement of Emission Characteristics and Requirements for LED UV-A Lamps Used in Fluorescent Penetrant and Magnetic Particle Testing

### 2.2 ASNT Documents:

Recommended Practice SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing<sup>3</sup>

ANSI/ASNT-CP-189 Standard for Qualification and Certification of Nondestructive Testing Personnel<sup>3</sup>

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.03 on Liquid Penetrant and Magnetic Particle Methods.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from The American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Lane, Columbus, OH 43228-0518.

### 2.3 Other Standards:

**ISO 9712 Nondestructive Testing—Qualification and certification of NDT Personnel**<sup>4</sup>

**AMS 2644 Inspection Material Penetrant**<sup>5</sup>

### 2.4 AIA Standard:

**NAS 410 Certification and Qualification of Nondestructive Testing Personnel**<sup>6</sup>

**2.5 DoD Contracts**—Unless otherwise specified, the issue of the documents that are DoD adopted are those listed in the issue of the DoDISS (Department of Defense Index of Specifications and Standards) cited in the solicitation.

**2.6 Order of Precedence**—In the event of conflict between this practice and the references cited herein, this practice takes precedence.

## 3. Terminology

**3.1 Definitions**—definitions relating to liquid penetrant examination, which appear in Terminology **E1316**, shall apply to the terms used in this practice.

Throughout this practice, the term “black light” has been changed to “UV-A” to conform with the latest terminology in **E1316**. “Black light” can mean a broad range of ultraviolet radiation; fluorescent penetrant inspection only uses the UV-A range.

## 4. Summary of Practice

**4.1** A post-emulsifiable, liquid, fluorescent penetrant is applied evenly over the surface being tested and allowed to enter open discontinuities. After a suitable dwell time and prerinse, the excess surface penetrant is removed by applying a hydrophilic emulsifier and the surface is rinsed and dried. A developer is then applied drawing the entrapped penetrant out of the discontinuity and staining the developer. If an aqueous developer is to be employed, the developer is applied prior to the drying step. The test surface is then examined visually under UV-A radiation in a darkened area to determine the presence or absence of indications. (**Warning**—Fluorescent penetrant examination shall not follow a visible penetrant examination unless the procedure has been qualified in accordance with **9.2**, because visible dyes may cause deterioration or quenching of fluorescent dyes.)

**4.2** Processing parameters such as precleaning, penetration time, prerinse, hydrophilic emulsifier concentration, etc., are determined by the specific materials used, the nature of the part under examination (that is, size, shape, surface condition, alloy), type of discontinuities expected, etc.

## 5. Significance and Use

**5.1** Liquid penetrant examination methods indicate the presence, location, and, to a limited extent, the nature and magnitude of the detected discontinuities. This practice is

normally used for production examination of critical components, where reproducibility is essential. More procedural controls and processing steps are required than with other processes.

## 6. Reagents and Materials

**6.1 Liquid Fluorescent Penetrant Testing Materials**, for use in the hydrophilic post-emulsification process, (see **Note 1**) consist of a family of post-emulsifiable fluorescent penetrant, hydrophilic remover, and appropriate developer and are classified as Type I Fluorescent, Method D—Post-Emulsifiable, Hydrophilic. Penetrant materials shall conform to AMS 2644 unless approved by the contract or Level III. Each penetrant and emulsifier are approved together as a pair. Intermixing of materials from various manufacturers is not recommended.

**NOTE 1**—Refer to **8.1** for special requirements for sulfur, halogen, and alkali metal content. (**Warning**—While approved penetrant materials will not adversely affect common metallic materials, some plastics or rubbers may be swollen or stained by certain penetrants.)

**6.2 Post-Emulsifiable Penetrants** are designed to be insoluble in water and cannot be removed with water rinsing alone. They are designed to be selectively removed from the surface by the use of a separate hydrophilic emulsifier. The hydrophilic emulsifier, at the proper concentration, properly applied, and given a proper emulsification time, combines with the excess surface penetrant to form a water-washable mixture, which can then be rinsed from the surface leaving the surface free of fluorescent background. Proper concentration and hydrophilic emulsification time must be experimentally established and maintained to assure that over-emulsification does not occur, resulting in loss of indications.

**6.3 Hydrophilic Emulsifiers** are liquids used to emulsify the excess oily fluorescent penetrant on the surface of the part, rendering it water-washable (see **7.1.6**). They are water-base emulsifiers (detergent-type removers) that are supplied as concentrates to be diluted with water and used as a dip or spray. The concentration, use, and maintenance shall be in accordance with manufacturer’s recommendations.

**6.3.1** Hydrophilic emulsifiers function by displacing the excess penetrant film from the surface of the part through detergent action. The force of the water spray or air/mechanical agitation in an open dip tank provides the scrubbing action while the detergent displaces the film of penetrant from the part surface. The emulsification time will vary, depending on its concentration. Its concentration can be monitored by the use of a suitable refractometer.

**6.4 Developers**—Development of penetrant indications is the process of bringing the penetrant out of discontinuities through blotting action of the applied developer, thus increasing the visibility of the penetrant indications. Several types of developers are suitable for use with the hydrophilic penetrant process.

**6.4.1 Dry Powder Developers** are used as supplied (that is, free-flowing, noncaking powder) in accordance with **7.1.9.1(a)**. Care should be taken not to contaminate the developer with fluorescent penetrant, as the penetrant specks can appear as indications.

<sup>4</sup> Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

<sup>5</sup> Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, <http://www.sae.org>.

<sup>6</sup> Available from the Aerospace Industries Association of America, Inc., 1250 Eye St., N.W., Washington, DC 20005.

6.4.2 *Aqueous Developers* are normally supplied as dry powder particles to be either suspended or dissolved (soluble) in water. The concentration, use, and maintenance shall be in accordance with manufacturer’s recommendations (see 7.1.9.1(b). **(Warning—**Aqueous developers may cause stripping of indications if not properly applied and controlled. The procedure should be qualified in accordance with 9.2. )

6.4.3 *Nonaqueous, Wet Developers* are supplied as suspensions of developer particles in a nonaqueous, solvent carrier ready for use as supplied. Nonaqueous, wet developers form a coating on the surface of the part when dried, which serves as the developing medium for fluorescent penetrants (see 7.1.9.1(c). **(Warning—**This type of developer is intended for application by spray only.)

6.4.4 *Liquid Film Developers* are solutions or colloidal suspensions of resins/polymer in a suitable carrier. These developers will form a transparent or translucent coating on the

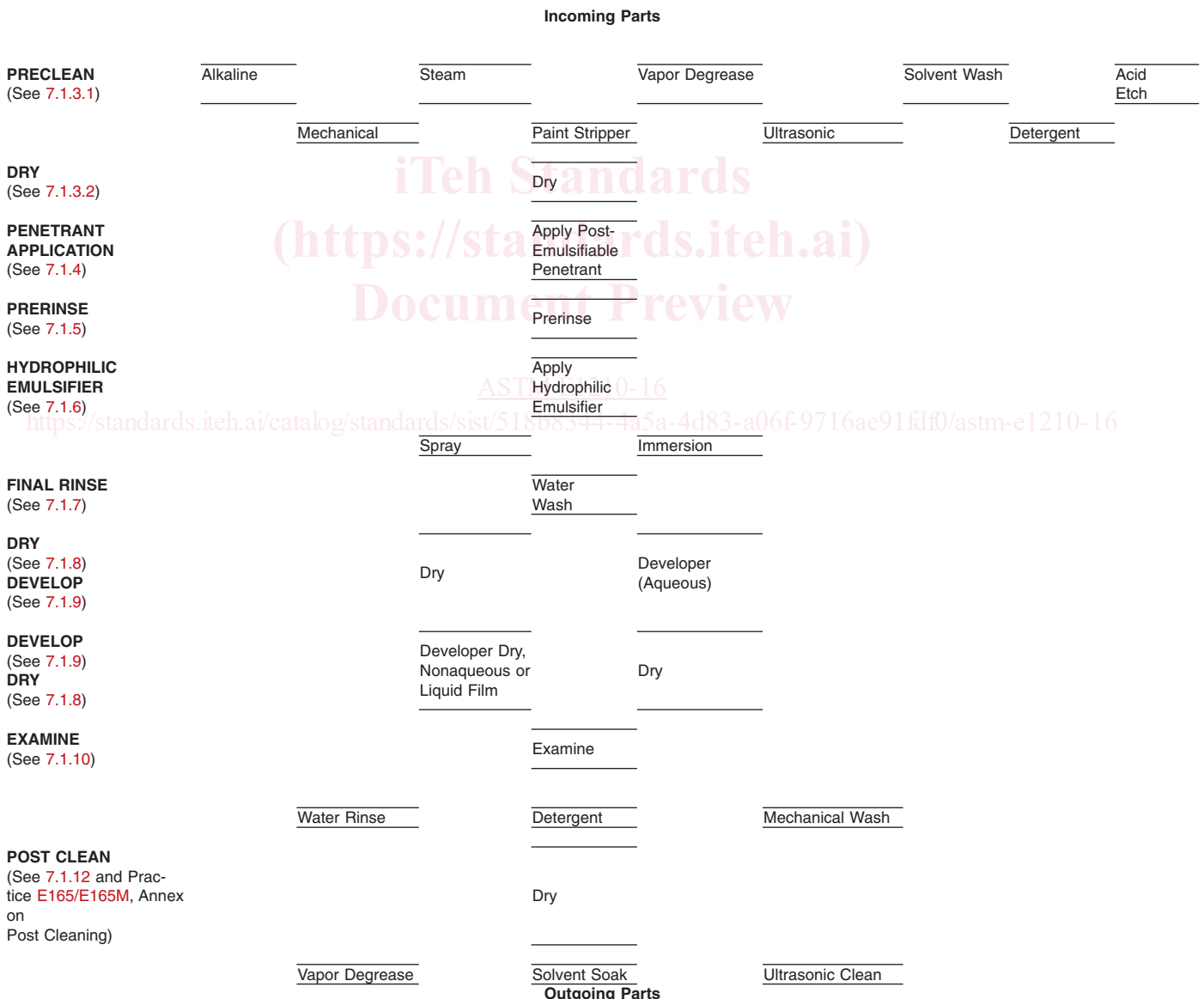
surface of the part. Certain types of film developer may be stripped from the part and retained for record purposes (see 7.1.9.1(d).

**7. Procedure**

7.1 The following general procedure applies to the fluorescent penetrant examination hydrophilic post-emulsification method (see Fig. 1).

7.1.1 *Temperature Limits*—The temperature of the penetrant materials and the surface of the part to be processed should be between 40 and 125°F (4 and 52°C). Where it is not practical to comply with these temperature limitations, qualify the procedure at the temperature of intended use as described in 9.2.

7.1.2 *Surface Conditioning Prior to Penetrant Inspection*—Satisfactory results may be obtained on surfaces in the as-welded, as-rolled, as-cast, or as-forged conditions or for



**FIG. 1 General Procedure Flowsheet for Fluorescent Penetrant Examination Using the Hydrophilic Post-Emulsification Process**